

10/088901

Rec'd PCT/PTO 27 AUG 2002

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of

Stefan SCHUERG et al

Based on PCT/DE 01/02029

For: Valve Assembly, In Particular For A Fuel Injection System
Of An Internal Combustion Engine

PRELIMINARY AMENDMENT

Commissioner of Patents
Washington, D.C. 2031

Sir:

Prior to examination, please amend the above-identified application as follows:

IN THE SPECIFICATION

Page 1, between the title and paragraph [0001], insert the following:

[0000.2] CROSS-REFERENCE TO RELATED APPLICATIONS

[0000.4] This application is a 35 U.S.C. 371 application of PCT/DE 01/02029 filed on
May 25, 2001.

[0000.6] BACKGROUND OF THE INVENTION

Replace paragraph [0001] with the following amended paragraph:

[0001] Field of the Invention

Between paragraphs [0002] and [0003], insert the following paragraph:

[0002.5] Description of the Prior Art

Page 2, replace paragraph [0005] with the following amended paragraph:

[0005] SUMMARY OF THE INVENTION

Page 8, delete paragraph [0019] in its entirety

Replace paragraph [0020] with the following amended paragraph:

[0020] BRIEF DESCRIPTION OF THE DRAWINGS

Replace paragraph [0021] with the following amended paragraph:

[0021] In the drawings, three exemplary embodiments of the invention are shown, which are described in further detail in the ensuing description, taken in conjunction with the drawings, in which:

Page 9, between paragraphs [0025] and [0026] insert the following:

[0025.5] DESCRIPTION OF THE PREFERRED EMBODIMENTS

Replace paragraph [0026] with the following amended paragraph:

[0026] The valve assembly shown in Fig. 1 is part of a Diesel reservoir-type injection system, also known as a common rail injection system, for an internal combustion engine for a motor vehicle. Here the valve assembly is built into an injector module, identified overall by reference numeral 10, which in a manner known per se and therefore not shown in further detail has an injection nozzle protruding into a cylinder combustion chamber of the engine and a nozzle needle that opens and closes the injection nozzle as a function of the pressure in a nozzle control chamber 12. The injector module 10 has a multi-part injector housing 14, in which a fuel supply conduit 16 supplied from a high-pressure distributor or rail is embodied, by way of which conduit

the injection nozzle is supplied with fuel. The control chamber 12 is also supplied with fuel from the fuel supply conduit 16 via a supply conduit (not shown) which is embodied in the injector housing 14 and is always open. If a high pressure prevails in the control chamber 12, then the nozzle needle subjected to this pressure closes the injection nozzle. If conversely a relief path 18 connected to the control chamber 12 is opened, then fuel flows out of the control chamber 12. The attendant pressure drop in the control chamber 12 causes the nozzle needle to open the injection nozzle, and fuel is injected into the cylinder combustion chamber. The valve assembly of the invention serves to open or close the relief path 18 selectively and accordingly serves to fix the instant and duration of injection.

Page 10, replace paragraph [0027] with the following amended paragraph:

[0027] The valve assembly includes a piezoelectric valve actuator unit 20, which is controlled by an electronic control unit, not shown, of the injection system and whose reciprocating bodies, preferably formed of many layers of piezoelectric material stacked one on the other, is braced on one end on a support wall 22 of the injector housing 14, while on the other end it acts on a control piston 26 guided displaceably in a larger-diameter portion of a stepped bore 24 of the injector housing 14. The reciprocating motions of the control piston 26 are transmitted, via a hydraulic force transmission chamber 28, to an operative piston 30 guided displaceably in a smaller-diameter portion of the stepped bore 24, which piston is firmly engaged by a valve element 32, embodied here as a seat element. The seat element 32 is adjustable in a valve chamber 34 between two opposed valve seats 36, 38 and is prestressed toward the valve seat 36 by a valve spring 40. The relief path 18 extends via the valve chamber 34; it has both

an outlet conduit 42, discharging into the valve chamber 34 in the region of the valve seat 38 and communicating with the control chamber 12, which outlet conduit as a rule includes an outlet throttle, not identified by reference numeral here, and also a return conduit 44, which extends out of the valve chamber 34 in the region of the valve seat 36 and in which the fuel that has flowed out of the control chamber 12 returns to a fuel source, from which a high-pressure pump pumps the fuel into the high- pressure distributor.

Page 12, replace paragraph [0029] with the following amended paragraph:

[0029] The force transmission chamber 28 is filled with fuel from the fuel supply conduit 16. To that end, in the injector housing 14, a branching conduit 46 is embodied, which branches off from the fuel supply conduit 16 and returns to the fuel source. Branching off in turn from the branching conduit 46 is a filling conduit 48, which is likewise embodied in the injector housing 14 and which discharges into the force transmission chamber 28. Viewed in the flow direction longitudinally of the branching conduit 46, one schematically represented throttling region 50 and 52 each is embodied in the branching conduit 46 one on each side of the branching point of the filling conduit 48. The two throttling regions 50, 52 form a pressure distributor assembly, by means of which a desired pressure can be set in the force transmission chamber 28 by division downward of the pressure prevailing in the fuel supply conduit 16. The throttling region 52 located downstream of the branching point serves to set the fuel quantity that returns to the fuel source; this quantity must not exceed a limit dependent on the power of the fuel pump, so that the fuel pump will not be overloaded. In terms of terminology, it

should also be noted that the branching conduit 46 will hereinafter also be called the main conduit of the pressure distributor assembly.

Page 13, replace paragraph [0032] with the following amended paragraph:

[0032] In the variant of Fig. 2, the throttling regions 50a, 52a are each embodied as a throttle bore, which is embodied centrally in a disklike throttle body 54a and 56a, respectively, that is produced separately from the injector housing 14a. The two throttle disks 54a, 56a are inserted into the main conduit 46a and each rest on a respective diameter-narrowing annular step 58a and 60a of the main conduit 46a. To meet the aforementioned demand for different flow cross sections of the throttle bores 50a, 52a, the throttle bore 50a in the throttle disk 54a can for instance have a diameter of about 0.06 mm, while the throttle bore 52a in the throttle disk 56a can have a diameter of about 0.1 mm.

Page 14, replace paragraph [0034] with the following amended paragraph:

[0034] By means of the same kind of screw body 70a, screwed into a further female thread 68a of the main conduit 46a and having a central through bore 72a, the upstream throttle disk 54a, in terms of the branching point of the filling conduit 48a, is also firmly clamped against the annular step 58a. However, in this case, between the throttle disk 54a and the screw body 70a, a filtering body 74a that is impermeable to the fuel is also inserted; between its outer circumferential jacket and the conduit wall of the main conduit 46a, it defines a filter gap, in particular an annular filter gap. The gap width of this filter gap is dimensioned such that particles contained in the fuel that could

stop up the throttle bore 50a of the throttle disk 54a are filtered out. For the diameter given above as an example of about 0.06 mm of the throttle bore 50a, a gap width of about $30\mu\text{m}$ for the filter gap is recommended. Certainly care must be taken that the filter gap overall offer a flow cross section for the fuel that is substantially larger than the flow cross section of the throttle bore 50a, so that the filter gap itself makes no significant contribution to the upstream throttling action.

Page 18, after paragraph [0041], insert the following new paragraph:

[0042] The foregoing invention relates to preferred exemplary embodiments of the invention, it being understood that other variants and embodiments thereof are possible within the spirit and scope of the invention, the latter being defined by the appended claims.

Page 19, line 1, delete "Claims" and insert --We Claim--.

17. The valve assembly of claim 16, wherein at least the throttling region (52) located downstream of the branching point is embodied as a throttle bore (52a; 52b; 52c).

18. The valve assembly of claim 17, wherein the throttling region (50) located upstream of the branching point is also embodied as a throttle bore (50a; 50b).

19. The valve assembly of claim 16, wherein at least one of the throttling regions (50, 52) is formed by a throttle bore (50a, 52a; 50b), which is embodied in a throttle body (54a, 56a; 54b) produced separately from and retained solidly on the conduit housing (14a; 14b).

20. The valve assembly of claim 17, wherein at least one of the throttling regions (50, 52) is formed by a throttle bore (50a, 52a; 50b), which is embodied in a throttle body (54a, 56a; 54b) produced separately from and retained solidly on the conduit housing (14a; 14b).

21. The valve assembly of claim 18, wherein at least one of the throttling regions (50, 52) is formed by a throttle bore (50a, 52a; 50b), which is embodied in a throttle body (54a, 56a; 54b) produced separately from and retained solidly on the conduit housing (14a; 14b).

22. The valve assembly of claim 19, wherein the throttle body (54a, 56a; 54b) is embodied as a flat throttle disk with a central throttle bore (50a, 52a; 50b).

23. The valve assembly of claim 19, wherein the throttle body (54a, 56a; 54b) is inserted into a larger-diameter portion of the main conduit (46a; 46b) and is braced on a transitional step (58a, 60a; 58b) to a smaller- diameter portion of the main conduit (46a; 46b).

24. The valve assembly of claim 22, wherein the throttle body (54a, 56a; 54b) is inserted into a larger-diameter portion of the main conduit (46a; 46b) and is braced on a transitional step (58a, 60a; 58b) to a smaller- diameter portion of the main conduit (46a; 46b).

25. The valve assembly of claim 23, wherein the throttle body (54a, 56a; 54b) is fixed to the transitional step (58a, 60a; 58b) by means of a screw body (64a, 70a; 70b) screwed into the main conduit (46a; 46b), and the screw body (64a, 70a; 70b) forms an essentially unthrottled flow passage, preferably forming a central through bore (66a, 72a; 72b), for the hydraulic mainstream.

26. The valve assembly of claim 24, wherein the throttle body (54a, 56a; 54b) is fixed to the transitional step (58a, 60a; 58b) by means of a screw body (64a, 70a; 70b) screwed into the main conduit (46a; 46b), and the screw body (64a, 70a; 70b) forms an essentially unthrottled flow passage, preferably forming a central through bore (66a, 72a; 72b), for the hydraulic mainstream.

27. The valve assembly of claim 25, wherein the throttle body (54a; 54b) forms the throttling region located upstream of the branching point, and wherein a filtering

35. The valve assembly of claim 16, wherein the main conduit (46) branches off from a fuel supply line (16) that serves to deliver fuel to an injection nozzle of the engine.

ABSTRACT OF THE DISCLOSURE

A valve assembly for a fuel injection system of an internal combustion engine , which includes an adjustably disposed valve element, a piezoelectric actuator unit for adjusting the valve element, and a hydraulic force transmission chamber disposed in the force transmission path between the actuator unit and the valve element. A hydraulic pressure distributor assembly diverts at least one hydraulic filling stream to the force transmission chamber for filling it from a hydraulic mainstream, which distributor assembly has a conduit system embodied in a conduit housing and has both a main conduit, carrying the hydraulic mainstream, and at least one filling conduit, branching off from the main conduit and carrying the hydraulic filling stream. The pressure distributor assembly forms one hydraulic throttling region for the hydraulic mainstream each on both sides of the branching point of the filling conduit from the main conduit. At least one of the throttling regions is embodied as a throttle bore.

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION

Page 1, paragraph [0001] has been amended as follows:

[0001] [Prior Art] Field of the Invention

Page 2, paragraph [0005] has been amended as follows:

[0005] [Advantages of the Invention] SUMMARY OF THE INVENTION

Page 8, paragraph [0020] has been amended as follows:

[0020] [Drawings] BRIEF DESCRIPTION OF THE DRAWINGS

Paragraph [0021] has been amended as follows:

[0021] In the drawings, three exemplary embodiments of the invention are shown, which are described in further detail in the ensuing description[.] , taken in conjunction with the drawings, in which:

Page 9, paragraph [0026] has been amended as follows:

[0026] The valve assembly shown in Fig. 1 is part of a Diesel reservoir-type injection system, also known as a common rail injection system, for an internal combustion engine for a motor vehicle. Here the valve assembly is built into an injector module, identified overall by reference numeral 10, which in a manner known per se and therefore not shown in further detail has an injection nozzle protruding into a cylinder combustion chamber of the engine and a nozzle needle that opens and closes the

[0027] The valve assembly includes a piezoelectric valve actuator unit 20, which is controlled by an electronic control unit, not shown, of the injection system and whose reciprocating bodies, preferably formed of many layers of piezoelectric material stacked one on the other, is braced on one end on a support wall 22 of the injector housing 14, while on the other end it acts on a control piston 26 guided displaceably in a larger-diameter portion of a stepped bore 24 of the injector housing 14. The reciprocating motions of the control piston 26 are transmitted, via a hydraulic force transmission chamber 28, to an operative piston 30 guided displaceably in a smaller-diameter portion of the stepped bore 24, which piston is [solidly connected to] firmly engaged by a valve

[0029] The force transmission chamber 28 is filled with fuel from the fuel supply conduit 16. To that end, in the injector housing 14, a branching conduit 46 is embodied, which branches off from the fuel supply conduit 16 and returns to the fuel source. Branching off in turn from the branching conduit 46 is a filling conduit 48, which is likewise embodied in the injector housing 14 and which discharges into the force transmission chamber 28. Viewed in the flow direction longitudinally of the branching conduit 46, one schematically represented throttling region 50 and 52 each is embodied in the branching conduit 46 [on both sides] one on each side of the branching point of the filling conduit 48. The two throttling regions 50, 52 form a pressure distributor assembly, by means of which a desired pressure can be set in the force transmission chamber 28 by division downward of the pressure prevailing in the fuel supply conduit 16. The throttling region 52 located downstream of the branching point serves to set

the fuel quantity that returns to the fuel source; this quantity must not exceed a limit dependent on the power of the fuel pump, so that the fuel pump will not be overloaded. In terms of terminology, it should also be noted that the branching conduit 46 will hereinafter also be called the main conduit of the pressure distributor assembly.

Page 13, paragraph [0032] has been amended as follows:

[0032] In the variant of Fig. 2, the throttling regions 50a, 52a are each embodied as a throttle bore, which is embodied centrally in a disklike throttle body 54a and 56a, respectively, that is produced separately from the injector housing 14a. The two throttle disks 54a, 56a are inserted into the main conduit 46a and each rest on a respective diameter-narrowing annular step 58a and 60a of the main conduit 46a. To meet the aforementioned demand for different flow cross sections of the throttle bores 50a, 52a, the throttle bore 50a in the throttle disk 54a can for instance have a diameter of about 0.06 mm, while the throttle bore 52a in the throttle disk 56a can have a diameter of about 0.1 mm.

Page 14, paragraph [0034] has been amended as follows:

[0034] By means of the same kind of screw body 70a, screwed into a further female thread 68a of the main conduit 46a and having a central through bore 72a, the upstream throttle disk 54a, in terms of the branching point of the filling conduit 48a, is also firmly clamped against the annular step 58a. However, in this case, between the throttle disk 54a and the screw body 70a, a filtering body 74a that is impermeable to the fuel is also inserted; between its outer circumferential jacket and the conduit wall of the

main conduit 46a, it defines a filter gap, in particular an annular filter gap. The gap width of this filter gap is dimensioned such that particles contained in the fuel that could stop up the throttle bore 50a of the throttle disk 54a are filtered out. For the diameter given above as an example of about 0.06 mm of the throttle bore 50a, a gap width of about 30 μ m for the filter gap is recommended. Certainly care must be taken that the filter gap overall offer a flow cross section for the fuel that is substantially larger than the flow cross section of the throttle bore 50a, so that the filter gap itself makes no significant contribution to the upstream throttling action.

Page 23, the abstract has been amended as follows:

[VALVE ASSEMBLY, IN PARTICULAR FOR A FUEL INJECTION SYSTEM
OF AN INTERNAL COMBUSTION ENGINE]

[Abstract] ABSTRACT OF THE DISCLOSURE

A valve assembly [suitable in particular] for a fuel injection system of an internal combustion engine [is proposed], which includes an adjustably disposed valve element, [an actuator unit, in particular] a piezoelectric actuator unit[,] for adjusting the valve element, and a hydraulic force transmission chamber disposed in the force transmission path between the actuator unit and the valve element. [For diverting] A hydraulic pressure distributor assembly diverts at least one hydraulic filling stream[, to be delivered] to the force transmission chamber for filling it[,] from a hydraulic mainstream[, a hydraulic pressure distributor assembly (50b, 52b) is provided], which distributor assembly has a conduit system [(46b, 48b) that is] embodied in a conduit housing [(14b)] and has both a main conduit [(46b)], carrying the hydraulic mainstream, and at least one filling conduit [(48b)], branching off from the main conduit [(46b)] and carrying the hydraulic filling stream. The pressure distributor assembly [(50b, 52b)] forms one hydraulic throttling region [(50b, 52b)] for the hydraulic mainstream each on both sides of the branching point of the filling conduit [(48b)] from the main conduit [(46b)]. At least one of the throttling regions [(50b, 52b)] is embodied as a throttle bore. [(Fig. 3)]